

# Preliminary Findings from VDOT Demo on Dowel Alignment Using Magnetic Imaging Tool Scan-2

Mohamed Elfino, P.E., Ph.D.  
Assistant State Materials Engineer  
Shabbir Hossain, P.E., Ph.D.  
Research Scientist, VTRC

- VDOT
  - Kenneth Jennings
  - Jeff Martin & Robert Honeywell
- VTRC
  - Rick Childs
- CPTP/CTL
  - Tom Yu



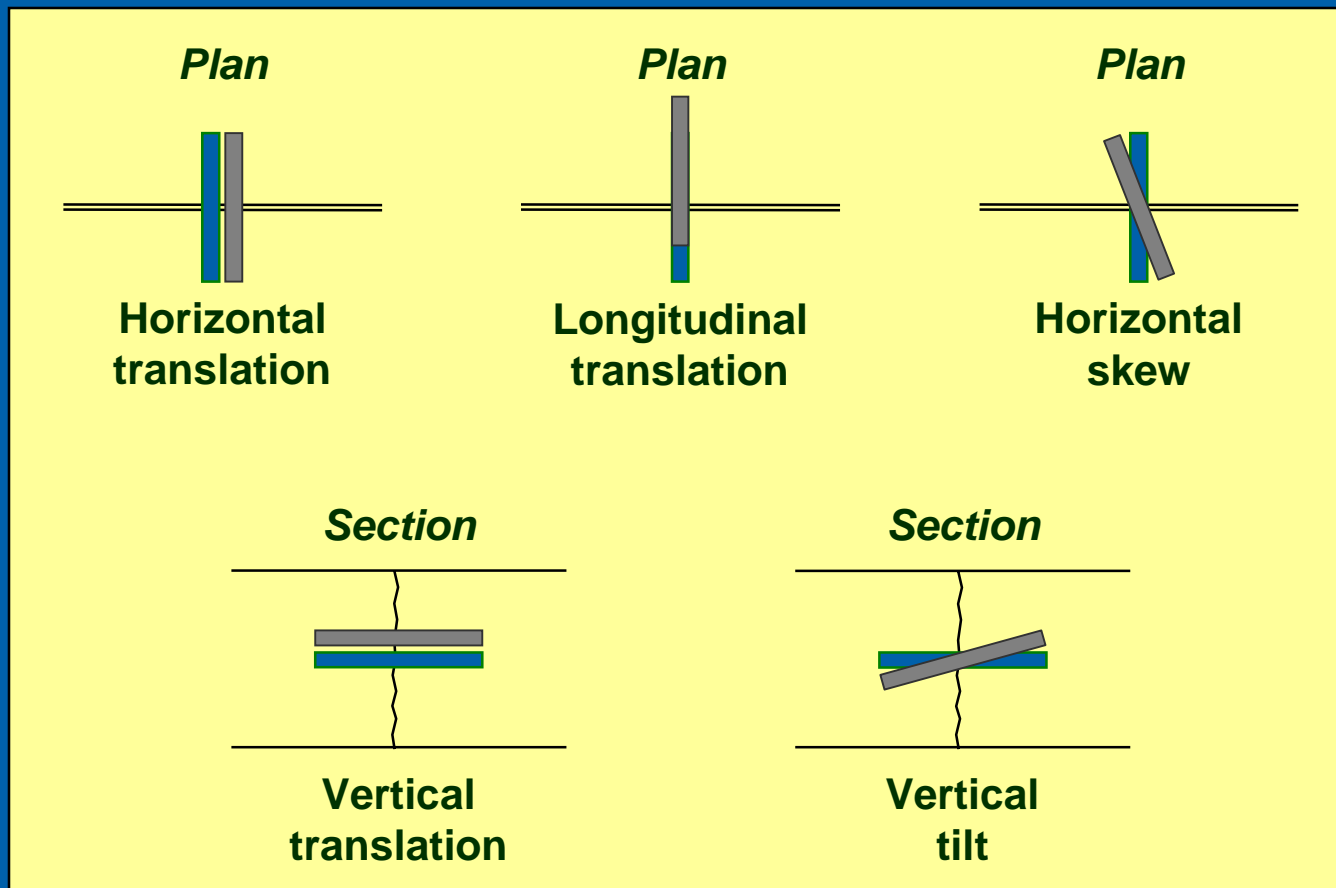
Device designed specifically for the measurement of dowel bar position and alignment

- Developed by Magnetic Imaging Tools, GmbH

Designed specifically for measuring dowel bar position and alignment using Magnetic tomography technology.



# Dowel Alignment



- Works on fresh or hardened concrete
- Real-time, automated data analysis
- Very accurate and reliable
- Efficient (1-2 min per joint)
  - 200 or more joints can be tested in an 8-hr workday
  - Up to 3 lanes can be tested in a single pass

## So what if dowels are misaligned?

- The effectiveness of dowel bars may be compromised
  - Loss of load transfer efficiency (LTE)
  - Premature development of faulting
- Pavement damage may result
  - Spalling
  - Cracking

- MIT SCAN-2 from FHWA under CPTP
- Training and Pilot Demo
  - US 460, Appomattox Bypass
  - November, 2005
- Perform scanning in different condition
  - Dowel Placement
  - Traffic Condition / Level
  - Five Demo Projects













- Very efficient
- Automated data analysis
- Real-time results
- Works on fresh or hardened concrete



(R) MIT GmbH  
 Gostritzer Str. 61-63  
 D-01217 Dresden, GERMANY  
 web : [www.mit-dresden.de](http://www.mit-dresden.de)  
 email : [mit@mit.tz-dd.de](mailto:mit@mit.tz-dd.de)

Federal Highway Administration  
 Office of Pavement Technology  
[sam.tyson@fhwa.dot.gov](mailto:sam.tyson@fhwa.dot.gov)  
 tel. :  
 web : [www.fhwa.dot.gov](http://www.fhwa.dot.gov)

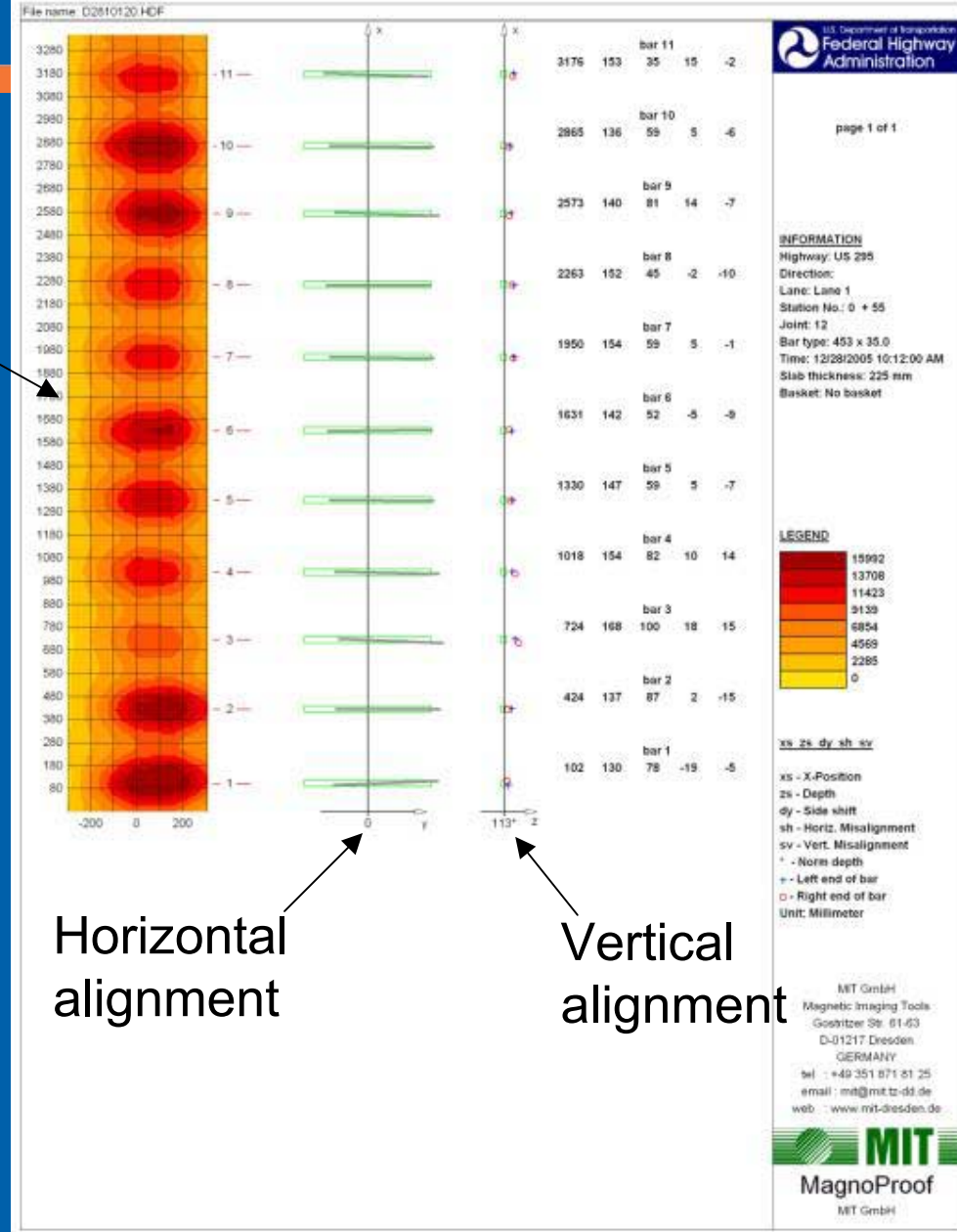
Date + Time : 26/08/2004 10:09  
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Highway : US 90  
 Direction : E  
 Station No. : 1 + 00  
 Lane : Lane 1  
 Joint : 1  
 Bar type : 454 x 38mm  
 Bar spacing : 300 mm  
 Concrete thickness : 280 mm

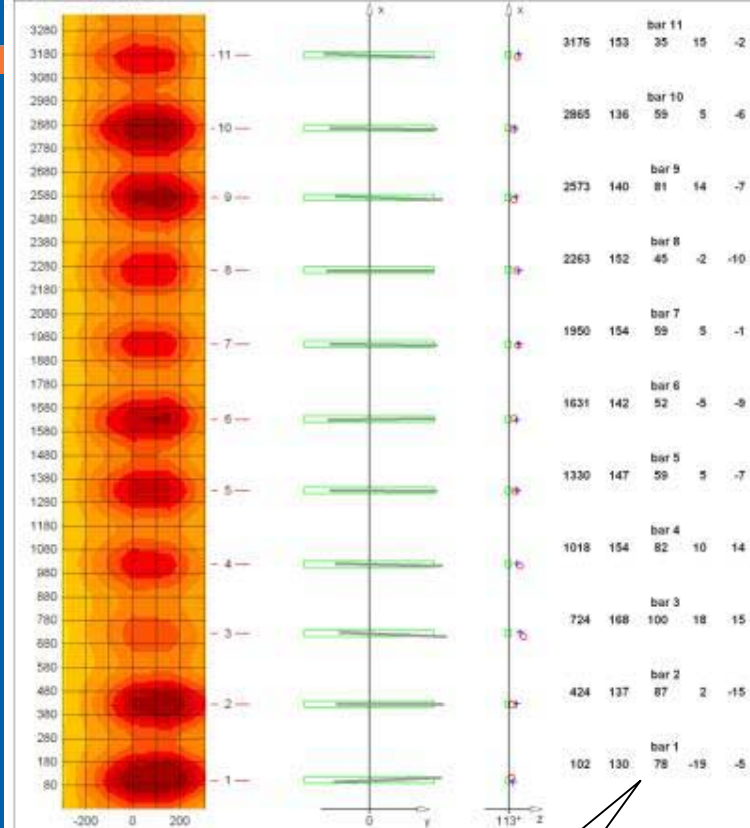
Bar No.	x-Location mm	Depth mm	Side Shift mm	Misalignm. hor. mm	Bar Space vert. mm	Bar Space mm
1	129	138	54	-19	8	129
2	455	146	25	-7	-6	326
3	766	148	-2	-3	-10	311
4	1071	143	27	0	-2	305
5	1379	151	-13	8	12	308
6	1690	151	-32	-1	4	311
7	1996	148	-19	-3	6	307
8	2302	137	10	2	2	305
9	2601	140	9	-2	-10	300
10	2908	137	-9	-3	0	307
11	3211	141	-17	8	-7	304
12	3516	144	-26	2	-2	304



Signal intensity  
Contour plot



File name: D2610120.HDF



page 1 of 1

**INFORMATION**

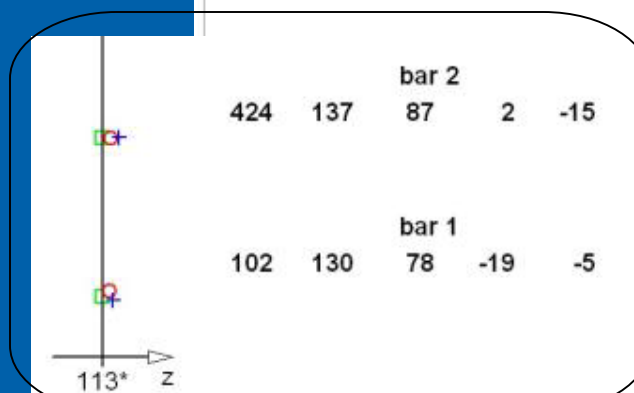
Highway: US 295  
Direction:  
Lane: Lane 1  
Station No.: 0 + 55  
Joint: 12  
Bar type: 453 x 35.0  
Time: 12/28/2005 10:12:00 AM  
Slab thickness: 225 mm  
Basket: No basket

**LEGEND**



**xs zs dy sh sv**

xs - X-Position  
zs - Depth  
dy - Side shift  
sh - Horiz. Misalignment  
sv - Vert. Misalignment  
\* - Norm depth  
+ - Left end of bar  
o - Right end of bar  
Unit: Millimeter



**xs zs dy sh sv**

xs - X-Position  
zs - Depth  
dy - Side shift  
sh - Horiz. Misalignment  
sv - Vert. Misalignment  
\* - Norm depth  
+ - Left end of bar  
o - Right end of bar  
Unit: Millimeter

# Five Demo Projects

- I-64 in Hampton Roads District
  - EB HOV in City of Chesapeake
  - JPCP Constructed 1997
- US 60 in James City County
  - Very old JRCP
- I-66 in NOVA (Fairfax County)
  - JPCP Constructed 1995
  - WB Lane Between US 50 and VA 28
- I-295 in Richmond (Henrico County)
  - CRCP Constructed 1987
  - Southbound lane south of US60
- US-460 in Lynchburg (Appomattox Bypass)
  - Eastbound between VA 26 to VA 24
  - JPCP Constructed in 1993-94



# Key Factors Affecting Dowel Alignment

- Basket
  - Placement prior to paving
  - Number and type of pins used for anchoring
- Dowel Bar Insertter (DBI)
  - Equipment type
  - Equipment adjustment
  - PCC mix design

- Dowel Basket
  - US 460
  - I-64
- Mechanically Inserted Dowel (DBI)
  - I-66
- JRCPP (No Dowel)
  - US 60
- Continuously Reinforced
  - I-295
  - No Transverse Steel

- All VDOT safety rules must be followed
- Traffic Control
  - Lane closer is preferable
  - Crash cushion in close proximity (25' to 50')
  - Rolling traffic control
    - Avoid bend or curve that obstruct long view
  - Traffic on the passing lane also need some control
- No injury reported

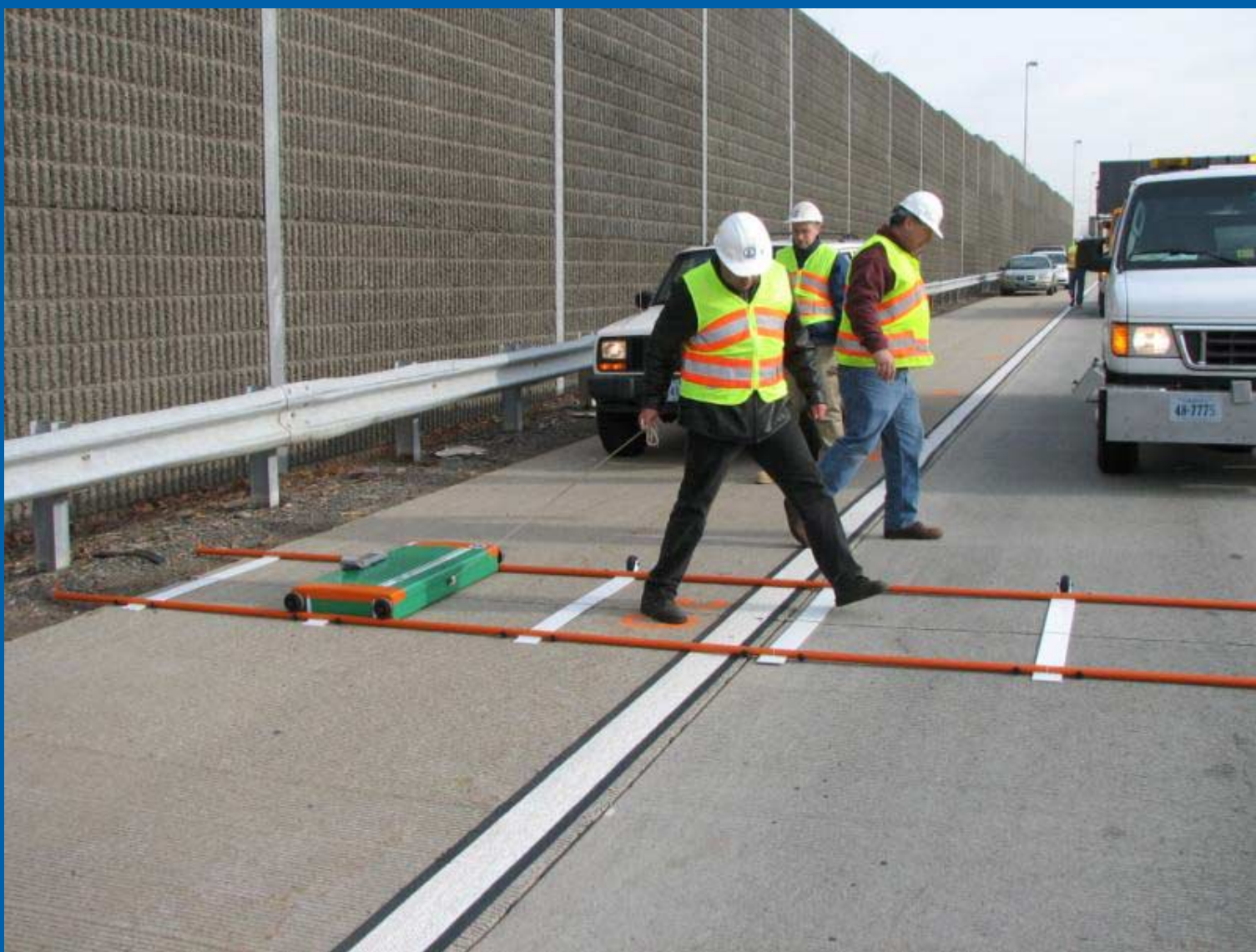
***“No data is worth someone’s life” - Ken Jennings***











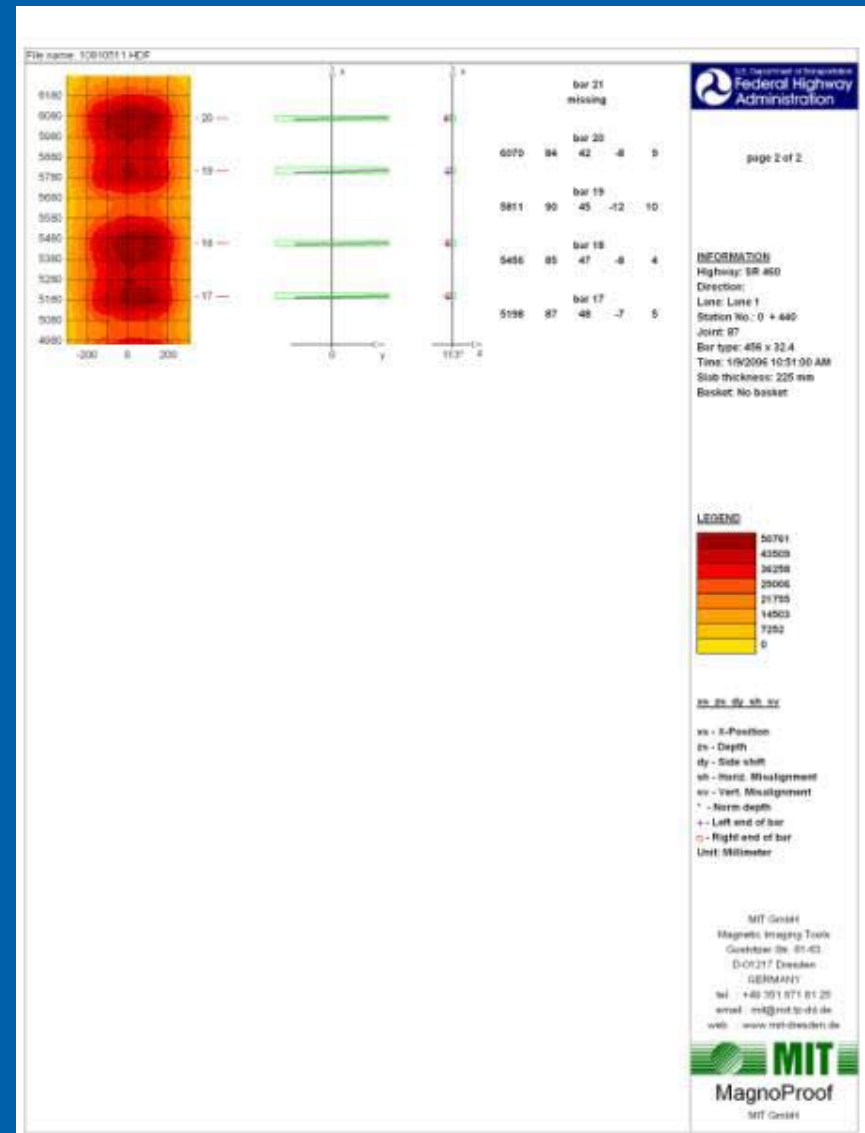




# Typical Results: US 460 Joint 87 (Travel and Acc. Lane)







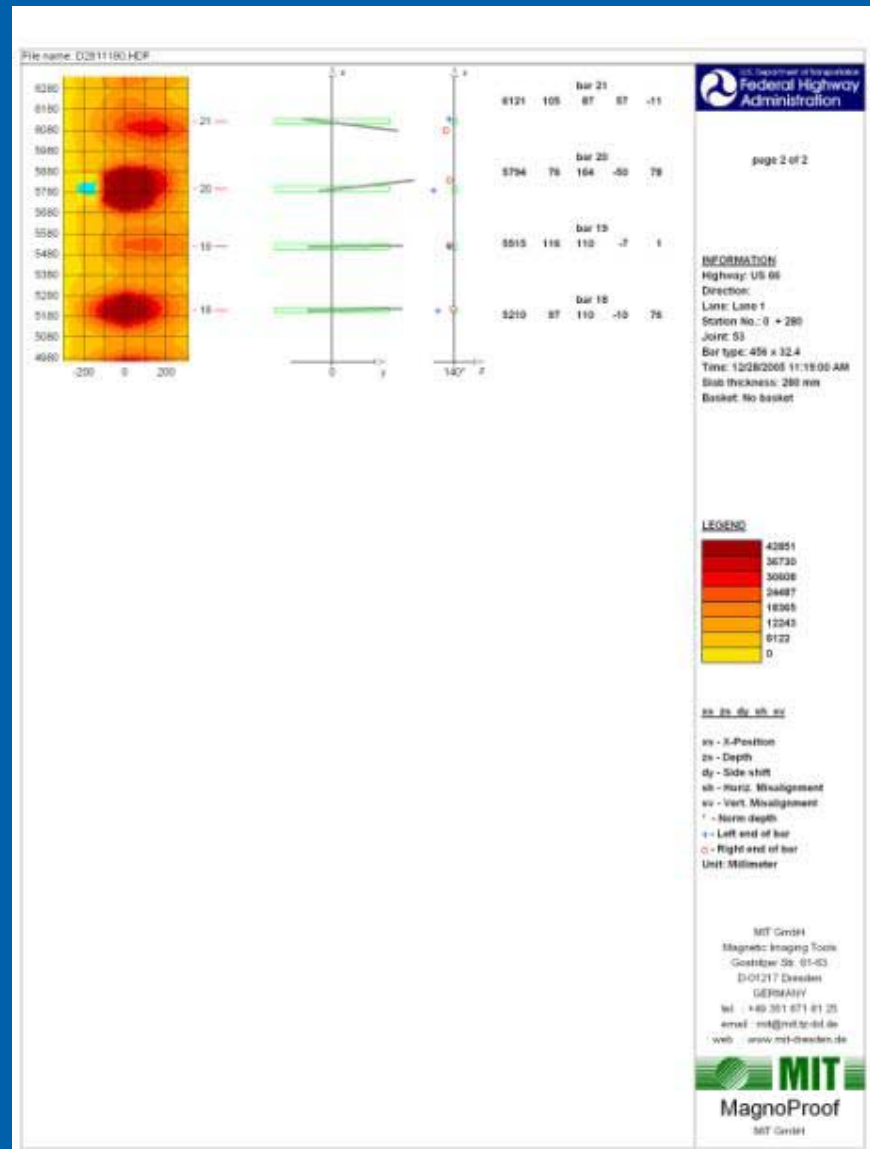
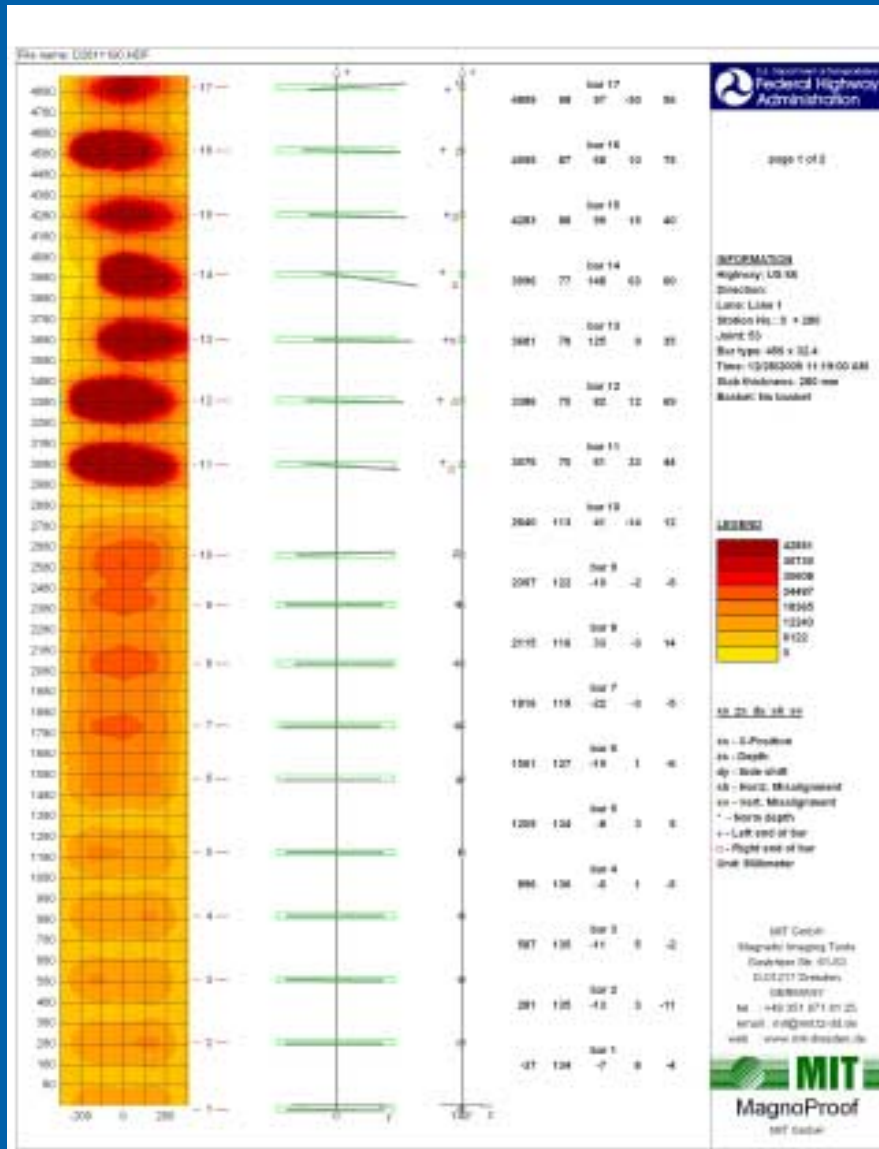
# Typical Results: I-66

Joint 54 (Travel Lane and shoulder)



# Typical Results: I-66

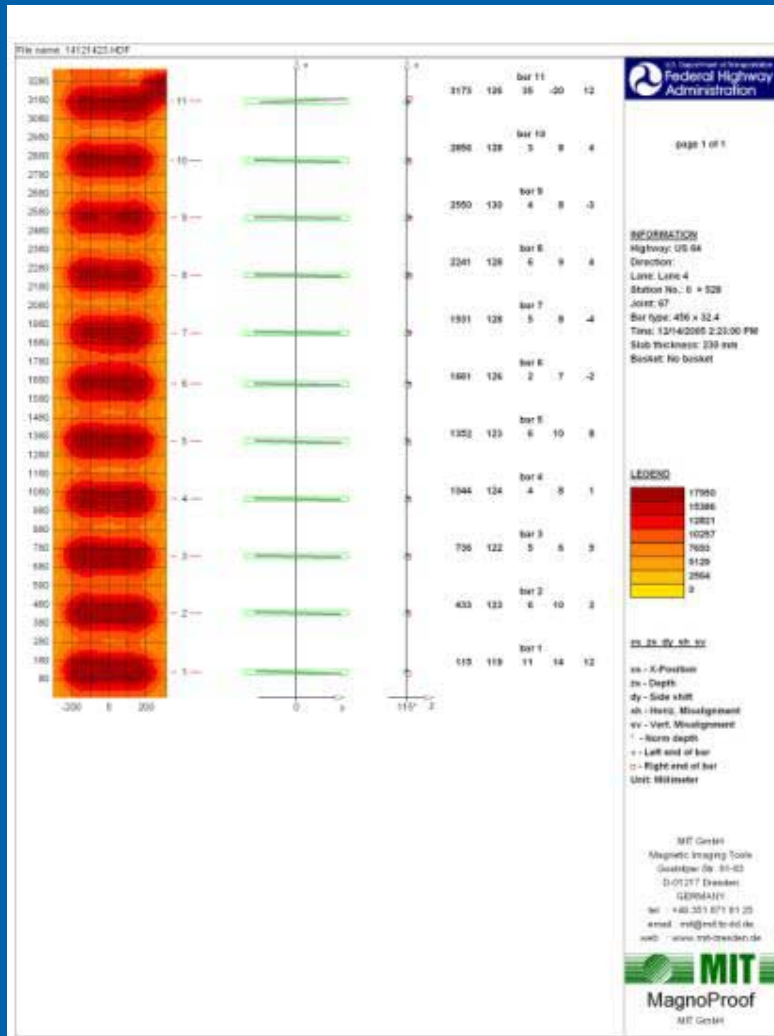
## Joint 54 (Travel Lane and shoulder)







# Typical Results: I-64, Joint 67



14121423.TXT

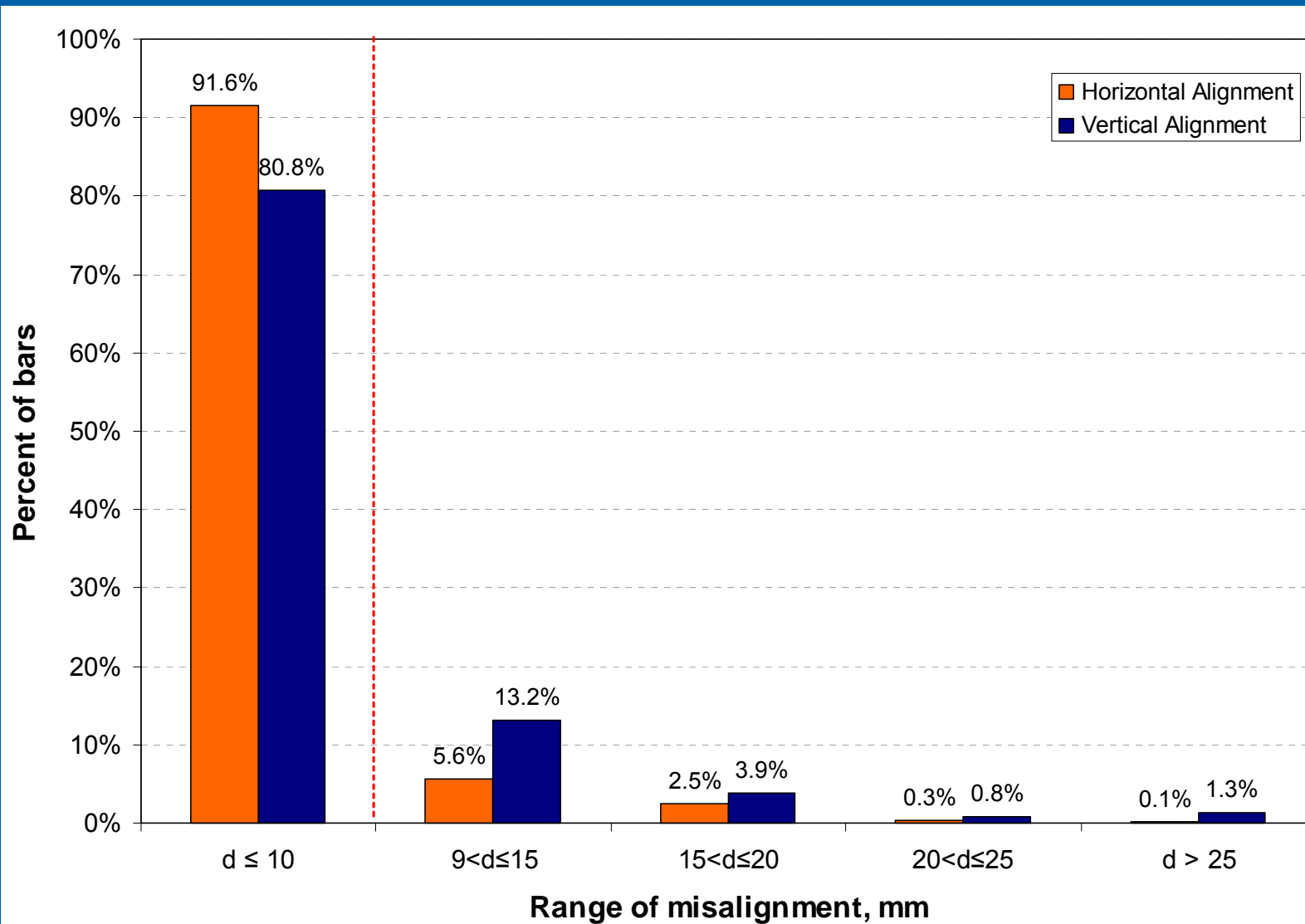
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D-01217 Dresden, GERMANY  
Web : www.mit-dresden.de  
Email : mit@mit.tz-dd.de

Date + Time : 14/12/2005 14:23  
File g:\05\_12\_14\14121423.hdf

Highway : US 64  
Direction : E  
Station No. : 0 + 528  
Joint : 67  
Lane : Lane 4  
Bar type : 454 x 38mm  
Bar spacing : 300 mm  
Concrete thickness : 230 mm

Bar No.	x-Location	Depth	side shift	Misalignm. hor.	Misalignm. vert.	Bar space
	mm	mm	mm	mm	mm	mm
1	119	130	2	13	9	119
2	432	135	-0	9	-0	313
3	736	134	-1	6	6	304
4	1044	137	0	6	-1	308
5	1352	136	1	10	6	308
6	1658	139	-0	5	-4	306 D
7	1933	141	-1	6	-6	275 D
8	2241	141	-1	7	2	308 D
9	2550	143	-0	5	-4	309 D
10	2857	141	-1	6	2	307 D
11	3164	137	27	-2	9	307

# Summary Result for I-64



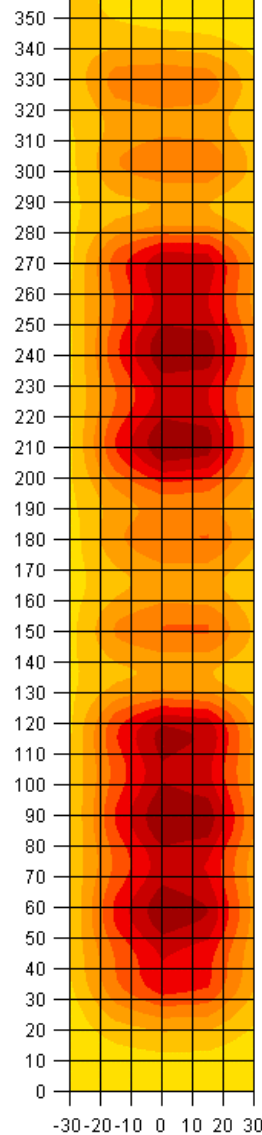
- Reflects the risk of joint locking – the higher the Joint score, the higher the risk
- Determined as a sum of product of number of bars at each level of misalignment and weighting factors
- Further research is needed to refine Joint Score

Range of misalignment, mm	Weight
$10 < d \leq 15$	0
$15 < d \leq 20$	2
$20 < d \leq 25$	4
$25 < d \leq 38$	5
$38 < d$	10

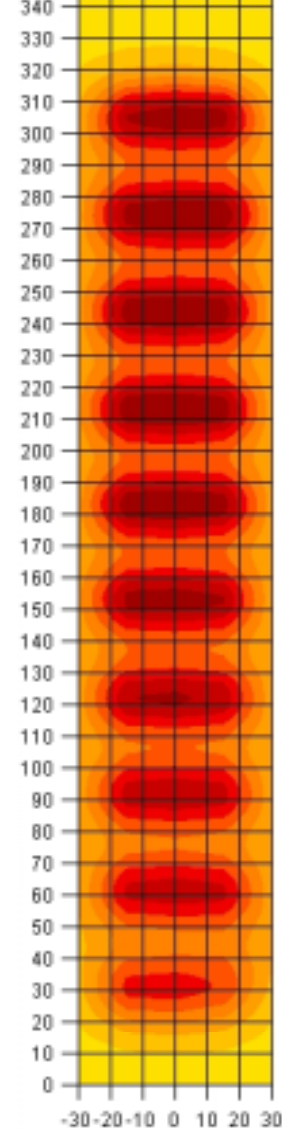
- Three replicate measurements
  - Interstate 64 at Hampton Roads District
  - Joints 1 through 9
  - 11 bars in each joint
  - 11 bars x 9 joints x 3 replicates
  - Total 297 measurements – 99 dowel bars @ 3 each
- Difference among replicate measurements
  - Depth – 100% within 2mm
  - Side Shift – 95% within 6mm
  - Horizontal Misalignments – 95% within 7mm
  - Vertical Misalignments – 98% within 2mm
- Statistical Repeatability
  - VDOT data – Analysis is being performed at VTRC
  - FHWA/ CPTP –  $\pm 5$  mm at 95% confidence level
  - Manufacturer –  $\pm 2$  mm for repeat measurements at same settings.

# Dowels placed in a basket

Bars must be insulated (epoxy coated), and the basket shipping wire is cut.



**Basket not cut**

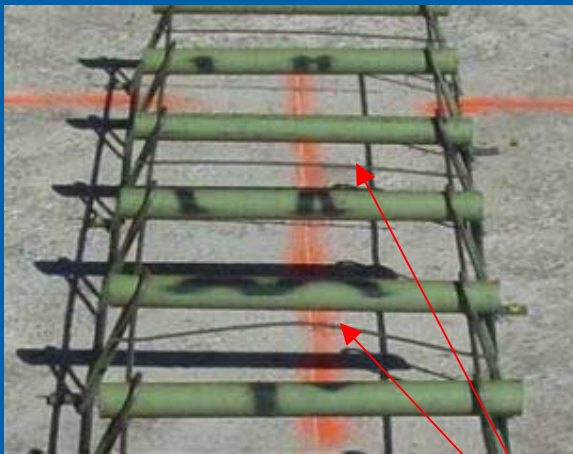


**Basket cut**



# Dowels placed in a basket

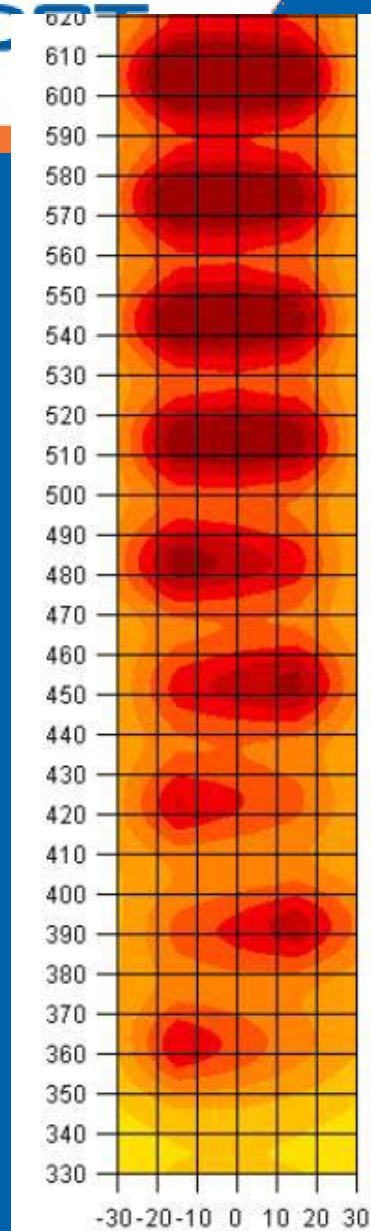
**Basket wire not cut**



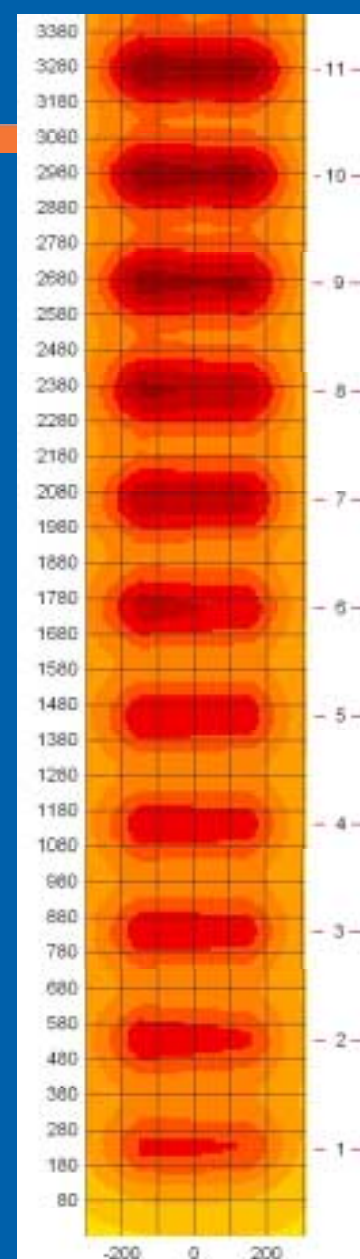
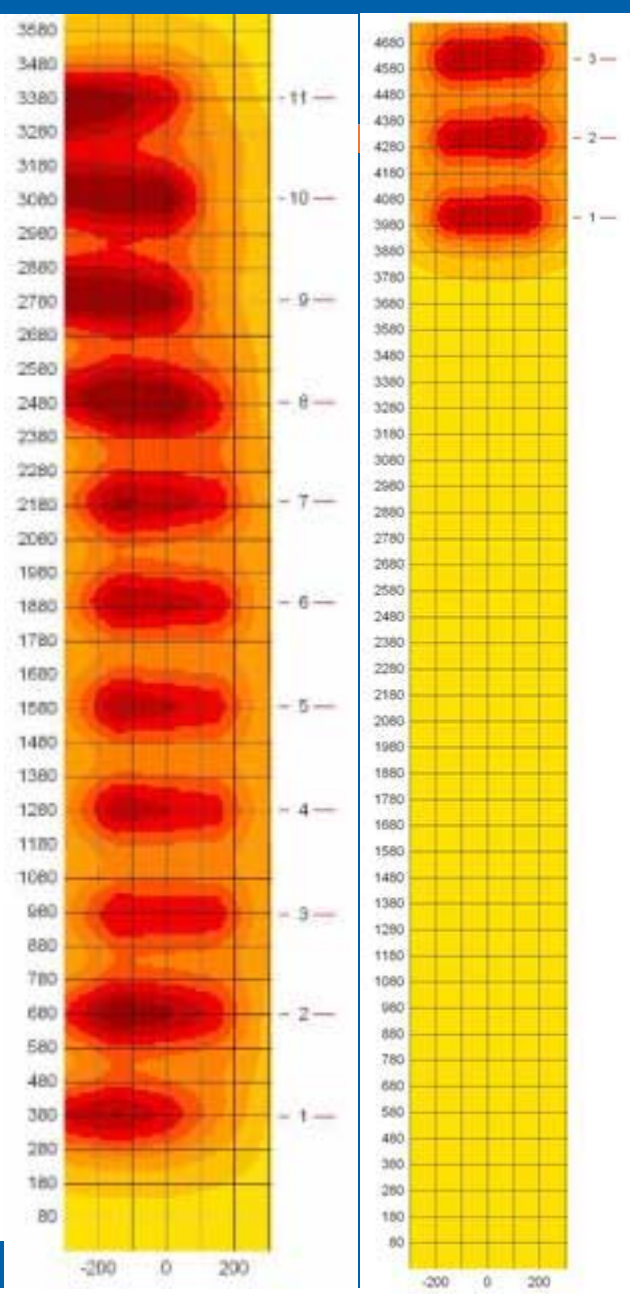
**Basket wire cut**



shipping wire



**Problem Joints**



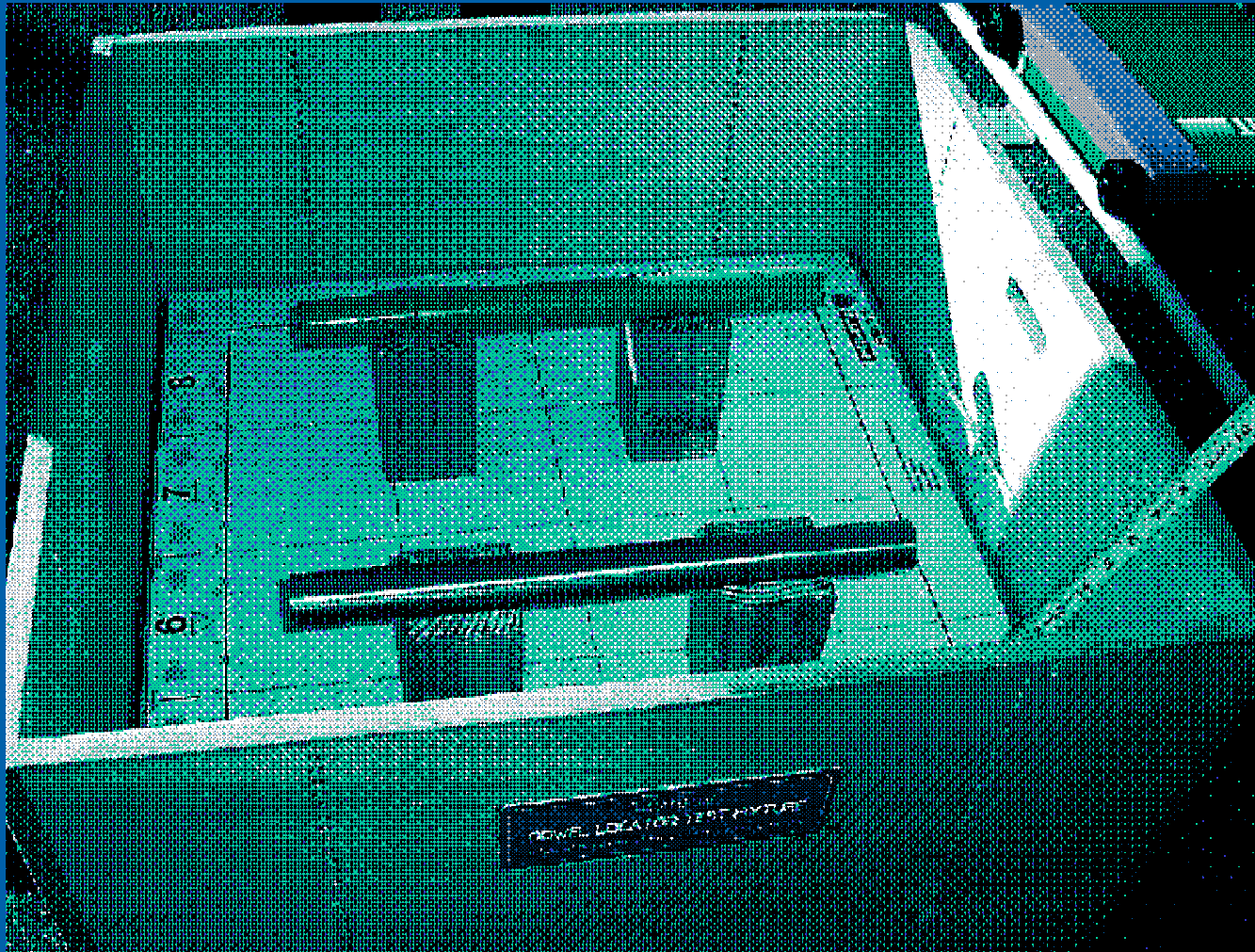
**Typical Joint**







# Caltrans Dowel Box



# Caltrans Dowel Box Testing



















- MIT Scan is user friendly
  - Learning was fast
  - Data analysis is more involved
- Safety concern
  - Existing pavement
  - Traffic control
- Areas of concerns with scanned data
  - Dowel basket shipping wire
  - Dowels deeper than 8 inch
  - Presence of tie bar

- MIT Scan Successfully performs
  - Mechanically inserted dowels
  - Dowels on the basket but shipping wire have to be cut
- MIT Scan would not do...
  - CRCP - Bar spacing and depth
  - JRCp - Interference from reinforcement
- CPTP Equipment Loan Program
  - Very efficient
  - Provided an opportunity to explore the new technology
  - Technical support is excellent



# 100 Years of Excellence



Thank You